REMARKS

An Excess Claim Fee Payment Letter is attached hereto to cover the cost of one excess independent claim.

Claims 1-2, 5, 7-9, 11 and 13-44 are all the claims presently pending in the application. Claims 7-8, 13-14, 16, 18, 10, 23, 26, 31 and 34 have been withdrawn from prosecution. Claims 1, 7-8, 41 and 43 have been amended to more clearly define the invention. Claim 44 has been added to claim additional features of the claimed invention.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-2, 5, 9, 11, 15, 17, 19, 21-22, 24-25, 27-30, 32-33 and 35-43 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pankove (U.S. Patent No. 4,862,471), Goetz et al. (U. S. Patent No. 6,441,393), Koike et al. (U. S. Patent No. 5,945,689) and Major et al. (U. S. Patent No. 6,100,546).

This rejection is respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention (e.g., as recited in claim 1) is directed to a light-emitting semiconductor device including a substrate, plural semiconductor layers which are made of group III nitride group compound semiconductor formed on the substrate, and an active layer having a multiple quantum well structure.

Importantly, the multiple quantum well structure includes a plurality of quantum well layers which satisfy the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x < 1$, and at least one quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with the plurality of quantum well layers, a composition ratio y of gallium (Ga) in the at least one quantum barrier layer being one of $y=1$, $y \approx 1$, and $0.9 < y \leq 1$.

Conventional light-emitting semiconductor devices may include a multiple quantum well (MQW) structure having well layers formed of GaInN and barrier layers formed of GaN.

However, such conventional devices experience problems. Specifically, in such devices, the performance life is short and the driving voltage (e.g., oscillation threshold) is high.

The claimed device, on the other hand, includes an active layer having a quantum well structure which includes a plurality of quantum well layers which satisfy the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x < 1$, and at least one quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with the plurality of quantum well layers. This allows the claimed invention to provide a light-emitting semiconductor device which emits rays having a desired and useful wavelength (Application at page 12, lines 8-11), and is able to reduce the amount of indium needed to form the quantum barrier layer (Application at page 13, lines 8-13).

II. THE PANKOVE, GOETZ, KOIKE AND MAJOR REFERENCES

The Examiner alleges that Pankove would have been combined with Goetz, that the alleged Pankove/Goetz combination would have been further combined with Koike, and that the alleged Pankove/Goetz/Koike combination would have been further combined with Major to form the claimed invention of claims 1-2, 5, 9, 11, 15, 17, 19, 21-22, 24-25, 27-30, 32-33 and 35-43. Applicants submit, however, that these references would not have been combined and, even if combined, the combination would not teach or suggest each and every element of the claimed invention.

First, Applicant would respectfully point out that the Examiner is surprisingly attempting to combine four references in order to rejection the claimed invention. Applicant respectfully submits that this alone establishes that the claimed invention is not obvious and that the Examiner has relied upon impermissible hindsight in attempting to reject the claims of the present Application, and thus, the Examiner has failed to establish a prima facie case of obviousness.

Pankove discloses a light-emitting device having a quantum well region including alternating layers 22 and 24 of gallium nitride and either indium nitride or aluminum nitride. (Pankove at Drawing; Abstract).

Goetz discloses a semiconductor device having an active layer 14 which may include AlInN, but does not disclose or suggest any composition ratios of either the aluminum or indium in the active layer, and does not disclose or suggest whether the AlInN is in the well

layers or barrier layers of a multiple quantum well structure (Goetz at Figure 1; col. 2, lines 38-45; col. 3, lines 49-53).

Koike discloses a light-emitting device having an emission layer 5 having a multiple quantum well structure, in which the quantum well layer may include AlGaN (Koike at col. 3, lines 58-60) or AlGaInN (Koike at col. 4, lines 30-33).

Major discloses a III-V arsenide-nitride semiconductor device in which group III elements are combined with group V elements, in concentrations chosen to lattice match commercially available crystalline substrates (Major at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to completely different problems and objectives. Thus, no person of ordinary skill in the art would have considered combining the references as alleged by the Examiner, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, nowhere do the references teach or suggest such a combination as alleged by the Examiner. Thus, the Examiner has clearly failed to make a prima facie case of obviousness.

Moreover, neither Pankove, nor Goetz, nor Koike, nor Major, nor any combination thereof teaches or suggests *"a quantum well layer which satisfies the formula* $Al_{1-x}In_xN$, *where a composition ratio x of indium (In) is in a range of* $0.1 \leq x < 1$; *and a quantum barrier layer which satisfies the formula* $Al_{1-z-y}Ga_yIn_zN$ $(0 \leq y \leq 1,\ 0 \leq z < 1,\ 0 \leq z+y \leq 1)$, *alternately formed with said quantum well layer"*, as recited in claim 1 similarly recited in claims 39 and 43.

As noted above, unlike conventional light-emitting semiconductor devices which may include a quantum well layer formed of GaInN and quantum barrier layer formed of GaN, the claimed device, includes an active layer having a multiple quantum well structure which includes a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x \leq 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ $(0 \leq y \leq 1,\ 0 \leq z < 1,\ 0 \leq z+y \leq 1)$, alternately formed with the quantum well layer, a composition ratio y of gallium (Ga) in the quantum barrier layer being one of $y=1$, $y \approx 1$, and $0.9 < y \leq 1$. With such a configuration, the claimed invention is able to provide a light-emitting semiconductor device which emits rays having a desired and useful wavelength (Application at page 12, lines 8-11), and is able to reduce the amount of indium needed to

form the quantum barrier layer (Application at page 13, lines 8-13).

Specifically, Applicant respectfully points out that the claimed invention includes an active layer having a plurality of quantum well layers which satisfy the formula $A1_{1-x}In_xN$, where a composition ratio x of indium (In) is in a range of $0.1 \leq x < 1$. That is, the well layer in the multiple quantum-well structure has a composition of $A1_{1-x}In_xN$, where $x \neq 1$. Accordingly, Al (e.g., in addition to Indium) becomes an essential component of the quantum well layers in the claimed invention.

Applicant respectfully submits that no prior art teaches or suggests that $A1_{1-x}In_xN$, in which Al and In (e.g., in the form of AlInN) are essential components, is used to form a well layer and that a barrier layer is formed to have composition $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$).

Certainly, these features are not taught or suggested by the cited references. Indeed, the Examiner alleges that this feature is taught by Pankove at col. 2, lines 23-30. However, this is clearly not correct.

In fact, this passage in Pankove merely teaches a quantum well region including alternating layers 22 and 24 of gallium nitride and either indium nitride or aluminum nitride. Thus, Pankove teaches that the alternating layers 22 and 24 may include either indium or aluminum but not both. Nowhere does Pankove even recognize the importance of having both aluminum and indium (e.g., in the form of AlInN) in the well layers. Thus, Pankove is clearly very different from and fails to teach or suggest the features of the claimed invention in which aluminum and indium are both important to the well layers in the semiconductor device.

Similarly, Goetz does not teach or suggest the features of the claimed invention. Indeed, as noted above, Goetz merely teaches a semiconductor device having an active layer 14 which may include AlInN. However, Goetz does not disclose or suggest any composition ratios of either the aluminum or indium in the active layer, and does not disclose or suggest whether the AlInN is in the well layers or barrier layers of a multiple quantum well structure (Goetz at Figure 1; col. 2, lines 38-45; col. 3, lines 49-53).

In fact, like Pankove, Goetz does not even recognize the importance of having both Al and In (e.g., in the form of AlInN) in a quantum well layer. Moreover, Goetz certainly does not teach or suggest a composition ratio x of indium (In) in a quantum well layer, which is in

a range of $0.1 \leq x < 1$. Thus, Goetz clearly does not make up for the deficiencies of Pankove.

Similarly, Koike does not teach or suggest the features of the claimed invention. Indeed, as noted above, Koike merely teaches a light-emitting device having an emission layer 5 having a multiple quantum well structure, in which the quantum well layer may include AlGaN (Koike at col. 3, lines 58-60) or AlGaInN (Koike at col. 4, lines 30-33).

That is, like Pankove and Goetz, Koike does not even recognize the importance of having both Al and In (e.g., in the form of AlInN) in a quantum well layer. Thus, Koike clearly does not make up for the deficiencies of the alleged Pankove/Goetz combination.

Similarly, Major does not teach or suggest the features of the claimed invention. Indeed, as noted above, Major merely teaches a III-V arsenide-nitride semiconductor device in which group III elements are combined with group V elements, in concentrations chosen to lattice match commercially available crystalline substrates (Major at Abstract).

In fact, like Pankove, Goetz and Koike, Major does not even recognize the importance of having both Al and In (e.g., in the form of AlInN) in a quantum well layer. Thus, Major clearly does not make up for the deficiencies of the alleged Pankove/Goetz/Koike combination.

The Examiner attempts to rely on Figure 2 in Major to support his position. However, Figure 2 in Major is merely a graph plotting the bandgap and lattice constant of AlGaInN wurtzite crystals superimposed with the lattice constant of some common substrates (Major at col. 6, lines 17-19). Figure 2 may be used, for example, to select a substrate on which to form certain compounds, based on a lattice matching.

However, Figure 2 in Major does not teach or suggest an active layer having a multiple quantum well structure which includes a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x < 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with the quantum well layer. Indeed, Figure 2 says nothing about a multiple quantum well structure of an active layer and is completely unrelated to such a structure.

Indeed, nowhere does Major teach or suggest the novel features of the claimed invention. Specifically, nowhere does Major teach or suggest the claimed composition ratios for the quantum well layer and the quantum barrier layer of the claimed invention. Therefore,

contrary to the Examiner's allegations, Major does not make up for the deficiencies of the alleged Pankove/Goetz/Koike combination.

Therefore, Applicant submits that these references would not have been combined, and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-2, 5, 9, 11, 15, 17, 19, 21-22, 24-25, 27-30, 32-33 and 35-44, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 9/17/04

Phillip E. Miller, Esq.
Registration No. 46,060

McGinn & Gibb, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254